Integrated WLAN/Bluetooth front-end module

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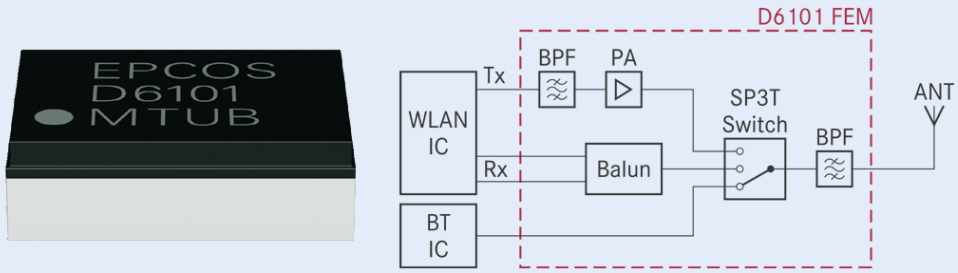
Mini FEM with maxi performance

WLAN functionality is moving into ever more applications. It was initially used predominantly in the computer sector, but now MP3 players, games consoles, radios, TV sets and mobile phones all have access to wireless power. Its use in ever more compact mobile phones places high demands on filtering and miniaturization.

With the D6101, EPCOS has developed the world's most compact fully integrated WLAN/Bluetooth front-end module (FEM) that satisfies all the requirements of state-of-the-art mobile phones. This FEM combines excellent selectivity, low power consumption, high linearity and minimum dimensions. In addition, it is also less expensive than discrete solutions.

Apart from sophisticated filters, the WLAN/Bluetooth FEM incorporates semiconductor components such as power amplifiers and switches, matching and bias networks, baluns and ESD protection. This means that only a minimum number of external components that are uncritical in RF terms are subsequently needed (Fig. 1). The D6101 is also fully compatible with all common WLAN and Bluetooth chipsets.

FIGURE 1: CIRCUIT DIAGRAM OF THE WLAN/BLUETOOTH FEM D6101



The D6101 module generates all functions between the WLAN and/or Bluetooth chipset and the antenna.

The highly integrated module design considerably reduces the number of required components – with all the advantages this entails: reduced logistics, lower space requirement on the circuit board, fewer solder points and higher reliability.

The D6101 was developed specifically for mobile phone applications with the aim of meeting the following challenges:

- Miniaturization
- Highly efficient filtering
- Unregulated battery operation
- Low power consumption and high linearity
- ESD protection
- Fast time-to-market

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With a footprint of only 4.5 x 3.2 mm² and an insertion height of 1.4 mm, the D6101 is currently the most compact fully integrated FEM for WLAN/Bluetooth applications designed to the 802.11 b/g/n and Bluetooth 2.1 standards. Other solutions with a lower degree of integration, such as power switch modules (PSM), need many external components, including filters. They take up as much as 40 percent more space on the circuit board than the D6101.

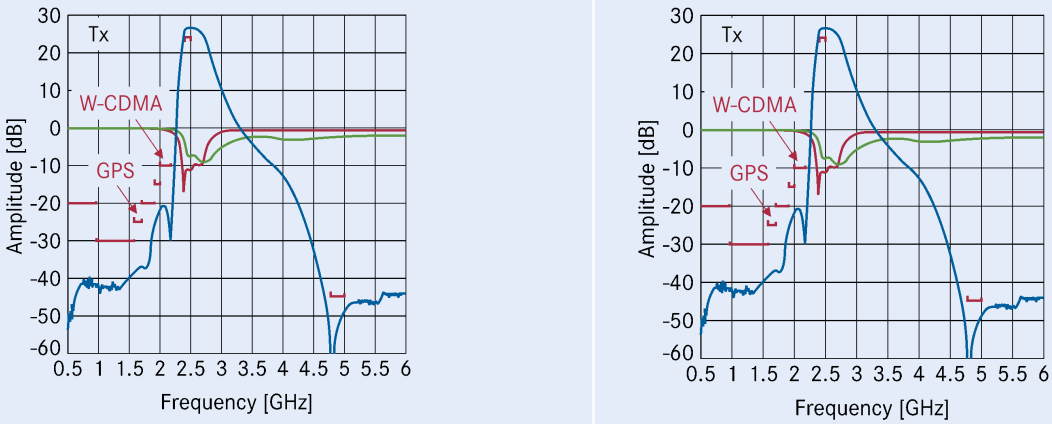
Outstanding filter properties

Unlike its use in notebooks, the WLAN function in mobile phones is operated in parallel with the usual mobile phone standards – GSM, UMTS and CDMA, thus placing exceptionally high demands on efficient filtering. EPCOS, world market leader in SAW filters, uses only its own technologies for the D6101, whose high performance consequently stands out from its global competitors.

The integrated coexistence filtering, based on the best currently available rejection-band attenuation, allows smooth simultaneous operation of WLAN/Bluetooth with all mobile phone standards, GPS and WLAN high-band. As shown in Fig. 2, all filtering specifications are observed. One of the greatest challenges is in operating WCDMA at 2.17 GHz together with the 800-MHz band. Other important frequencies are the WLAN high band at 5 GHz and the 2nd and 3rd harmonics at 4.8 and 7.2 GHz, respectively. Moreover, the GPS frequency at 1.5 GHz and other mobile phone bands must also be taken into consideration.

The D6101 features innovative ladder filtering incorporated in the LTCC substrate that reduces the group runtime. Moreover, it does not vary as strongly as pure SAW filtering in response to temperature fluctuations. With an insertion loss difference of only 0.5 dB over the entire pass band, RF power calibration can be carried out rapidly with minimum effort.

FIGURE 2: TX AND RX ATTENUATION CHARACTERISTICS OF THE D6101



Thanks to the ladder filtering integrated in the LTCC substrate, all required specifications are observed.

WLAN-FEMs in mobile phone applications are supplied directly from the battery and not via voltage controllers. The voltage varies between 3 and 4.5 volts, but in principle depends strongly on the charge level and loading. The D6101 assures a constant performance despite this range of voltages of 50 percent.

The gain varies by less than 1 dB over the entire voltage range. The linearity fluctuates by less than 2.5 percent at an output of 14 dBm and current consumption of less than 150 mA.

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Lower power consumption and high linearity

All components of a mobile phone must be optimized to minimize their power consumption in order to maximize the battery life. The challenge lies in simultaneously maximizing performance. Two aspects play a crucial role here: the bias network and the use of performance-optimized semiconductor components. If the bias network is not optimized, the linearity of the FEM is impaired. The D6101 has the advantage over PSM solutions that all biasing elements are already optimized and integrated in the FEM. Parasitic and layout effects are practically non-existent.

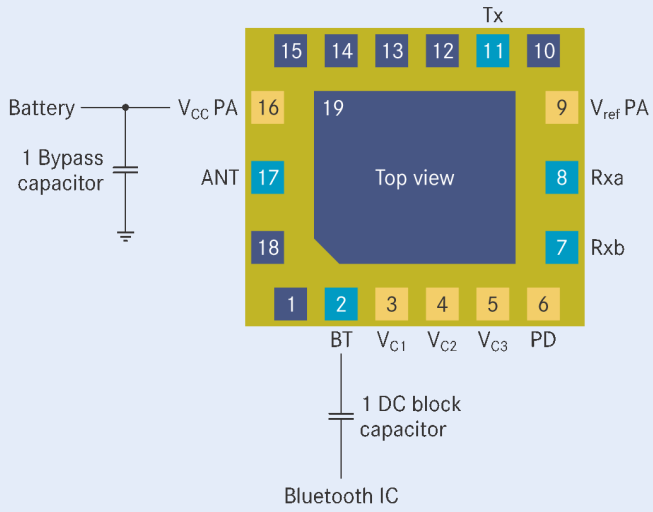
Integrated ESD protection

Electrostatic discharges can damage microelectronic components. The D6101 consequently offers fully integrated ESD protection. Its values of 1 kV HBM (human body model) at all pins, an 8 kV system level test at the antenna and 500 V CDM are significantly superior to standard PSM solutions. No additional components are needed for ESD protection.

Time-to-market critical for mobile phones

To shorten the time-to-market still further, the number of development cycles must be reduced. These cycles result from several factors, including the design of RF-critical components in the system. This group includes RF chokes and capacitors for the matching and bias networks, filters, as well as components for ESD protection. The D6101 is a plug-and-play solution developed to minimize the external components other than the chipset, so that no more than two capacitors are needed (Fig. 3). Three of a possible ten development cycles required for PSM solutions can consequently be dispensed with.

FIGURE 3: MINIMUM EXTERNAL CIRCUITS



Only two external capacitors are needed in addition to the chipset as external circuits.

Author: Bernardo Knoblich, Product Marketing Manager, SAW Wireless Terminals

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